

Fluids from the Neves Corvo ores

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Neves Corvo, the first Cu and Sn producer of Europe is the richest mine of the Iberian Pyrite Belt (IPB) which is the biggest metallogenic province of VMS deposits in the World.

Petrographic observations were carefully done, before fluid inclusion (FI) studies in order to determine the relationships quartz – sulphide phases and quartz – cassiterite, and to characterize the distinct FI types observed in each sample. The FI in minerals (mainly quartz, but also cassiterite and carbonate) from all the stratigraphic levels (including ores) were studied using conventional techniques (microthermometry and Raman analysis) and also microPIXE in selected inclusions.

The mine consists of five orebodies with a total of > 300 Mt of ores. Different massive sulphide ores are defined based on their metal content: MS > 2% Cu + > 1% Sn; MC > 2% Cu; MZ > 6 % Zn. ME (barren ore) is a non economic type with < 2 % Cu. Below and above the massive ores there are respectively stockwork (called fissural at the mine site) and *rubané* ores. Two types of *rubané* ores (a Cu, called RC and a Sn, called RT) are most prominent at Corvo orebody.

I have studied the MC, ME, RC, RT and FC (fissural Cu ore). A comparison with the fluids from the hanging wall was performed.

In all but the massive ore the main fluids are low salinity aqueous-carbonic, which frequently show liquid CO₂ at room temperature. Pressure oscillations frequently found in this fluids are interpreted as due to variations in the pressure regime from lithostatic to hydrostatic at the same depth. CO₂ + CH₄ are thought to have resulted from reactions with organic matter dispersed in the metasediments which are very common at the stockwork and *rubané* levels. The highest P-T conditions during metamorphism were estimated about 320 MPa and 350 °C.

Although quartz inside massive sulphide ores are a minor constituent I have sampled three areas where quartz are easily found. Petrographic evidences including pyrite plus chalcopyrite along growth zones in quartz suggests that quartz and sulphides are coeval in the studied samples. In the massive ores the most frequent fluid is a low salinity H₂O-NaCl fluid (3-6 % wt.eq.NaCl) but a aqueous-carbonic fluid with low density also occurred specially in intercrystalline domains. TH range from 140° to 370 °C with two distinct “peaks” one at 160°-170 °C and the other between 220°-280°C. In one sample it was observed a high-salinity H₂O-NaCl fluid with 30.4 % wt. eq. NaCl. This fluid is interpreted as occasional phase separation at depth that could derive from seawater or from a magmatic fluid. However the most likely cause for ore deposition probably was temperature decrease, although it seems that three separate events are registered (low, medium and high) in the evolution of the hydrothermal system.

Carbon isotopic ratios as a powerful biosignature in altered basaltic glass

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Over the past decade, the existence of a deep subsurface biosphere has been established. Microbial alteration of basaltic glass from *in situ* oceanic crust and ophiolites is perhaps one of the most exciting recent discoveries. However, the very existence of relics or true fossils of early life has proven to be very controversial. We suggest an unlikely substrate, altered marine basaltic glass, may preserve early indicators of ancient biological activity.

Carbon isotope signatures in MORB glass show differences from those of the adjacent crystalline cores that likely relate to microbial activity during alteration. The generally low δ¹³C ratios (<-7‰) of disseminated carbonates in basaltic glass are attributed to metabolic byproducts of *Bacteria* formed by oxidation of dissolved organic matter in pore waters. A few positive δ¹³C values have been observed. These come from slow-spreading ridges and suggest in those settings lithotrophic utilization of CO₂ in which methanogenic *Archaea* produced CH₄ from H₂ and CO₂.

The above isotopic evidence for biogenic alteration is from geologically young (~<120Ma) glass samples from *in situ* oceanic crust where petrological, geochemical, and microbiological methods document microbial activity. The challenge is to show which geochemical traces of microbial life in glass are preserved through metamorphism, deformation, and geological time. Microbial glass alteration is evident optically and isotopically in relict glass from the Troodos and Mirdita ophiolites but nucleic acid staining has failed to indicate the presence of DNA. Greenschist facies pillow rims from a Caledonide ophiolite have retained isotopic as well as some textural evidence of bioalteration of glass. In pillow margins of Proterozoic and Archean ophiolites we have found analogous carbon isotopic biosignatures but no textural indicators. We suggest that carbon isotopic ratios may serve as a biomarker in submarine basalt that survives metamorphism (so far demonstrated for greenschist and lower amphibolite facies) and deformation, possibly as far back as the Archean. Carbon isotope biosignatures will perhaps be found in the Earth's earliest submarine basalts, which according to some theories may have been the cradle of life itself.

We believe oceanic basalts also provide a good terrestrial analogue for studies of extraterrestrial samples since basalts are likely to be returned by any extraterrestrial sample return mission. Our techniques could be easily applied to samples returned from Mars and other extraterrestrial bodies where liquid water and conditions suitable for life may have existed.